

STATUS OF SEAL DEVELOPMENT AT TECHNETICS

Doug Chappel
Technetics Corporation
Indianapolis, Indiana

Technetics has recently reported results for blade tip seal rub characteristics. Expanding on this work, Technetics will share rub characteristics for knife edge abradable seal systems typical of those found at vane inner air seal and shaft seal locations.

Technetics
CORPORATION

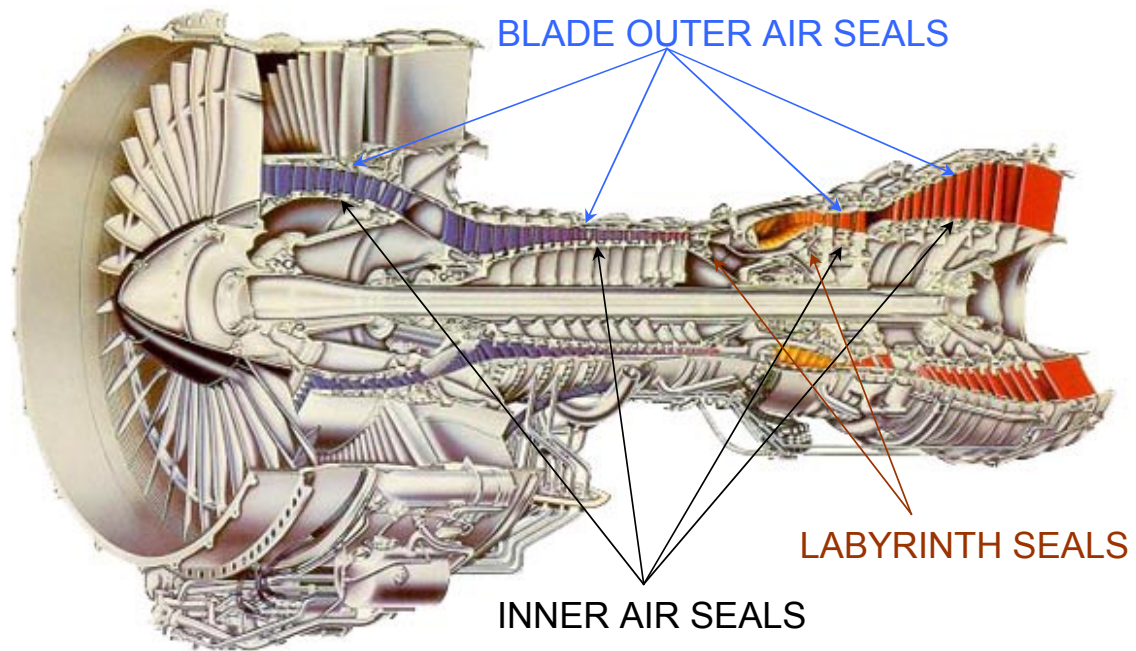


Abradable Seal Developments At Technetics

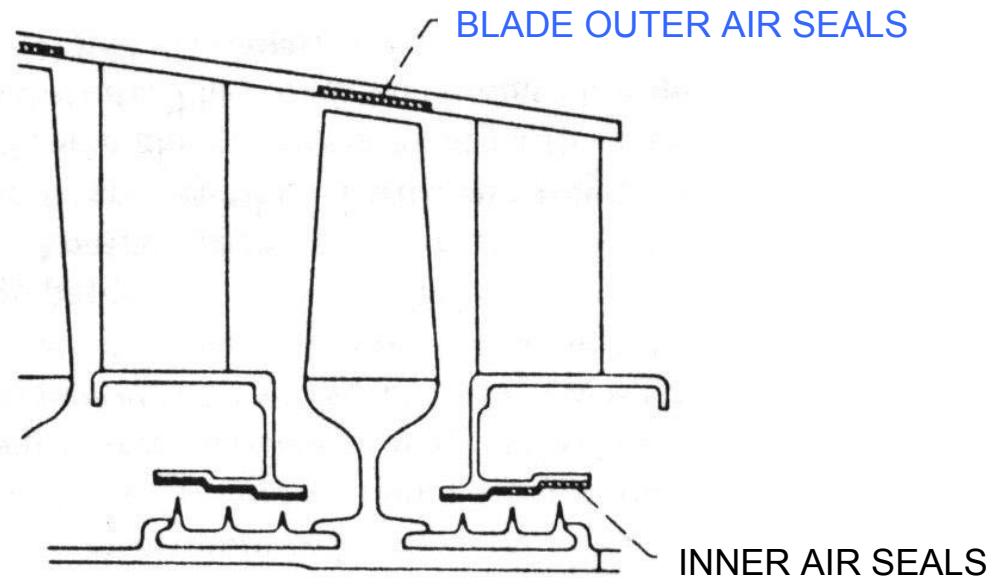
Doug Chappel

NASA Seal / Secondary
Air System Workshop
October 30, 2001

Typical Abradable Seal Applications

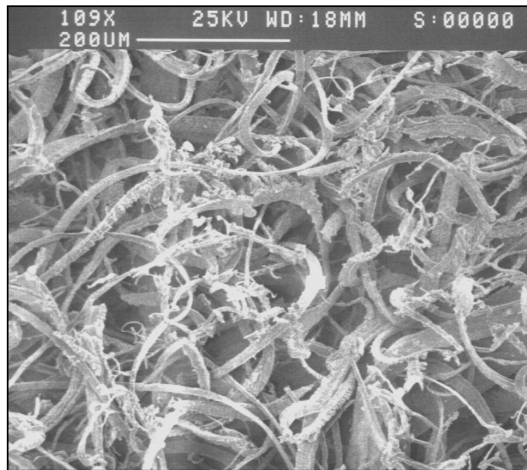


Typical Abradable Seal Applications

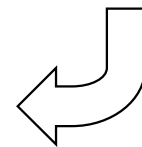
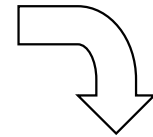


What Is Feltmetal®?

Micron Size Fiber Sinter Bonded Into A Continuous Felt



- Typically Hast-X or FeCrAlY
- Density Range 10 – 50%
- UTS Range 500 – 3000 psi
- Temperatures Up To 1400 F



Feltmetal® Compressor Abradable Materials Have Well Over 250 Million Hours Of Successful Operation

Manufacturer	Engine	Aircraft	Engines In Service	Total Engine Hours	
Pratt & Whitney	JT9D	B747, B767, A300, A310, DC-10	2,700	150 Million	
	PW2000	B757, IL-96, C-17	1,100	16 Million	
	PW4000	B747, B767, A300, A310, A330, MD-11	2,000	35 Million	
	F-100	F-15, F-16	6,500	-?-	
P&W Canada	Various	Various	0	0	Enters Service 2000
Rolls-Royce	RB211-524	B747, B767	1700	-?-	
	RB211-535	B757, Tu204	1300	18 Million	
	Trent 500	A340-500, 600	0	0	Enters Service 2001
	Trent 700	A330	60	-?-	
	Trent 800	B777	200	-?-	
	Trent 900	A3XX, B747-X	0	0	Enters Service 2004
	Industrial RB211	n/a	-?-	5 Million	Power Generation
	Industrial Trent	n/a	-?-	-?-	Power Generation
IAE	V2500	A319, A320, A321, MD-90	1300	3 Million	
Honeywell	AGT1500	M1 Abrams Battle Tank	10,000	-?-	

Key Requirements For Abradable Seal Materials

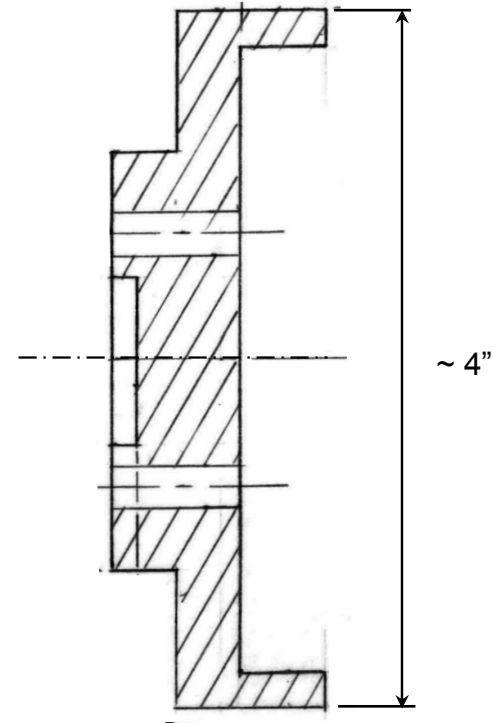
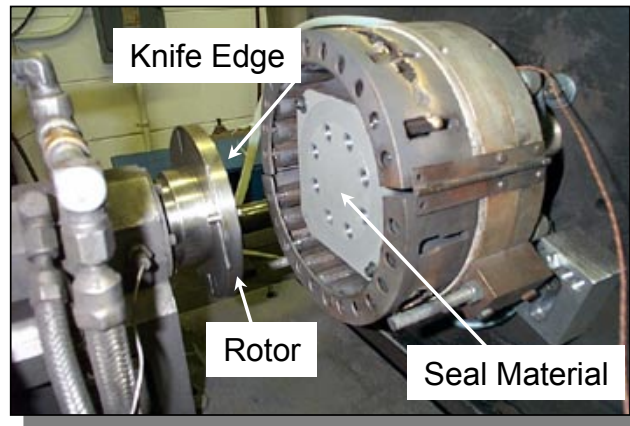
- Clean Cutting With Minimal Blade Wear
- Erosion Resistance
- Operating Life

➔ *Performance Is Application Specific*

<i>Typical GT Compressor</i>	AERO	UTILITY
Max Tip Speed	1400 fps	1200 fps
Max Temp	1300 F	1200 F
Incursion Rate	10 mil/sec	0.1 mil / sec
Incursion Depth	20 mils	40+ mils
Knife Edge Material	Ni, Ti	Steel
Knife Edge Thickness	25 mils	Up to 300 mils

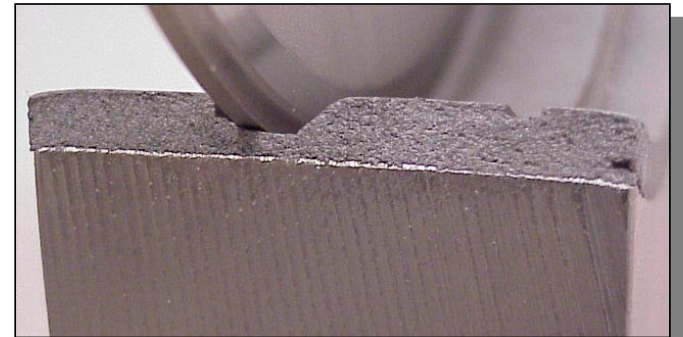
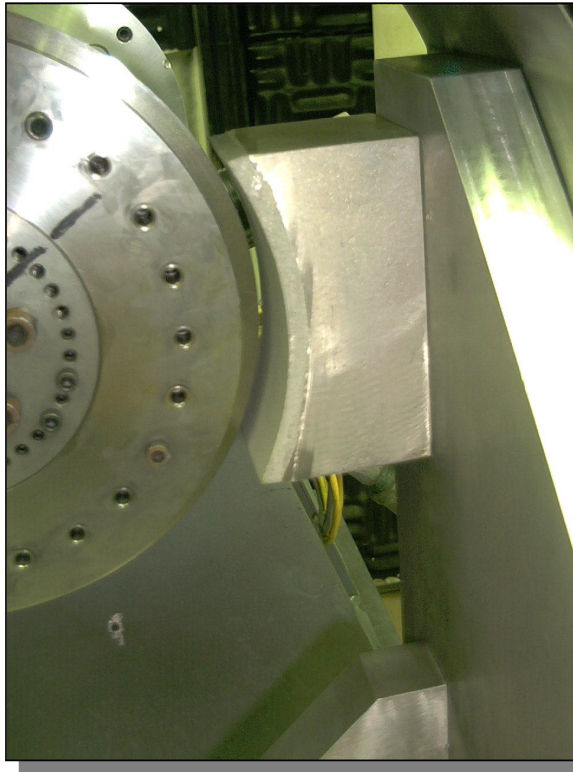
Face Configuration Abradability Rig

Motion Limited To Plunge Direction

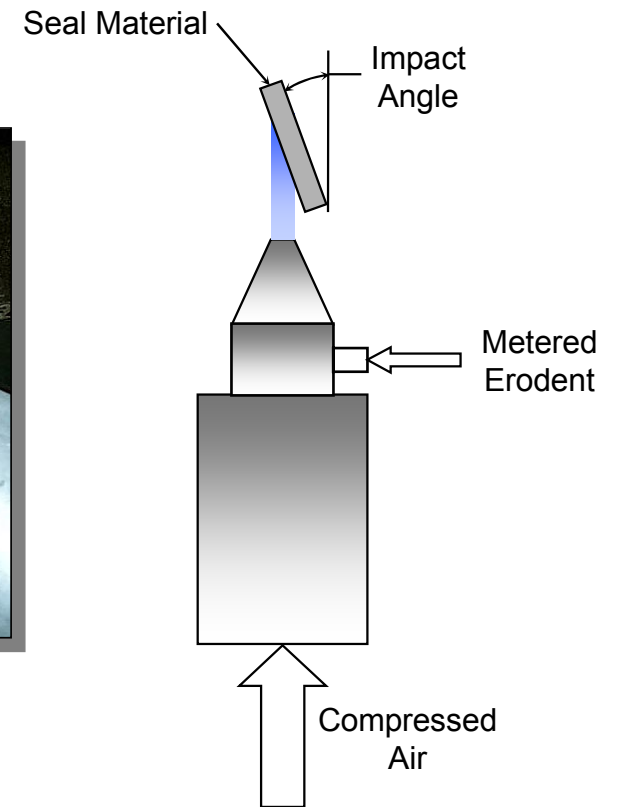


Radial Configuration Abradability Rig

Can Move In Plunge And Sweep Directions

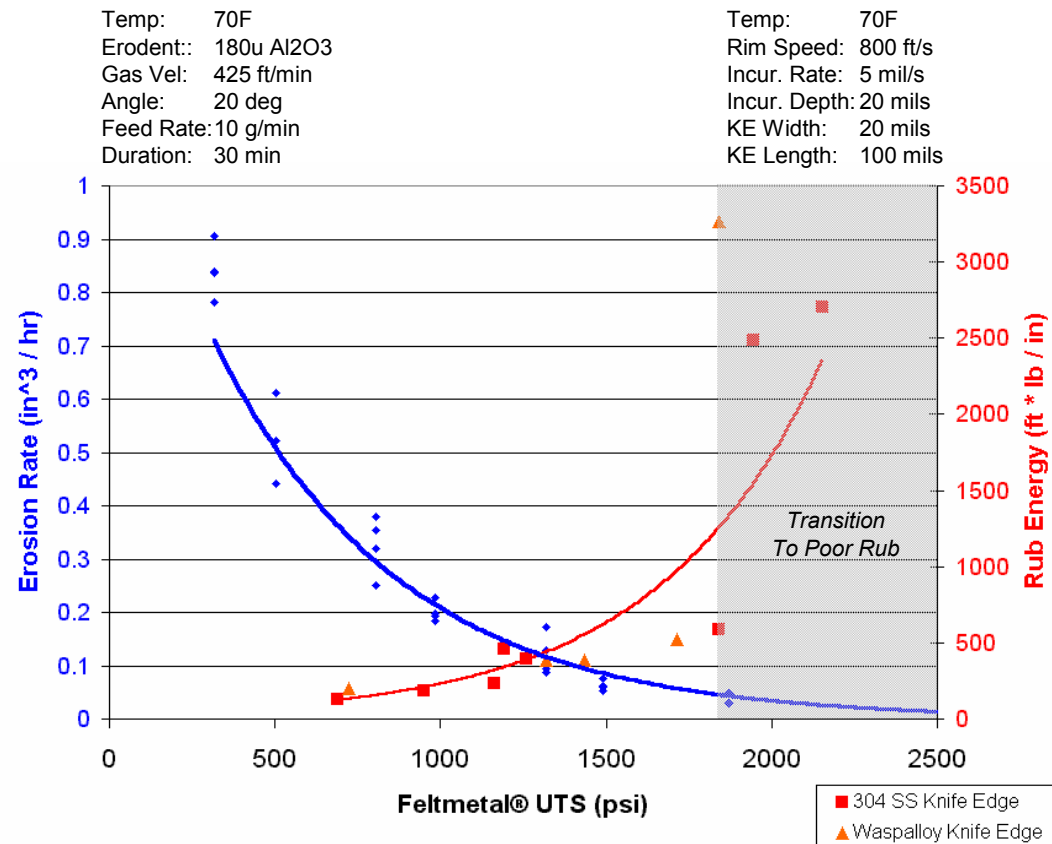


Erosion Test Rig



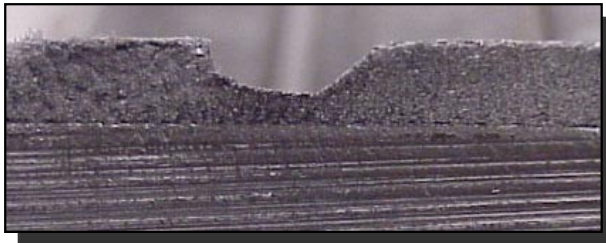
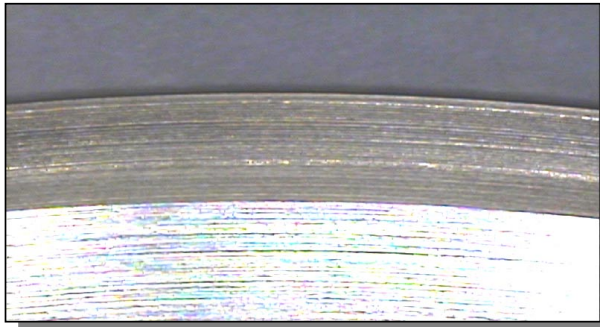
Plunge Data For “Aero” Conditions

Felt Tensile Strength Is The Driving Material Property

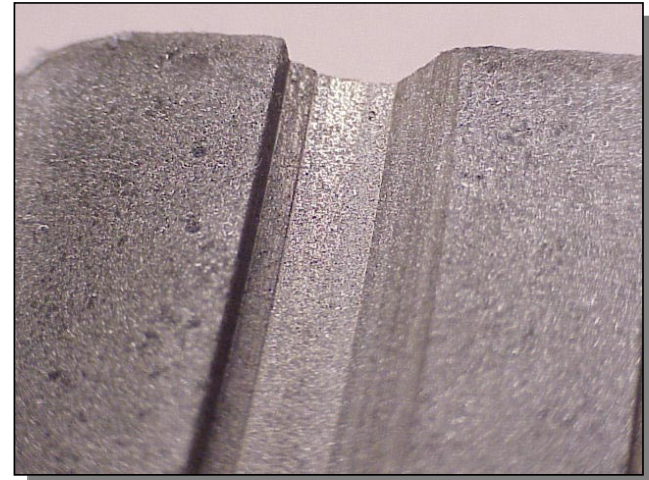


Plunge And Sweep Results For “Utility” Conditions

Clean-Cut Groove, No Blade Wear Or Thermal Distress



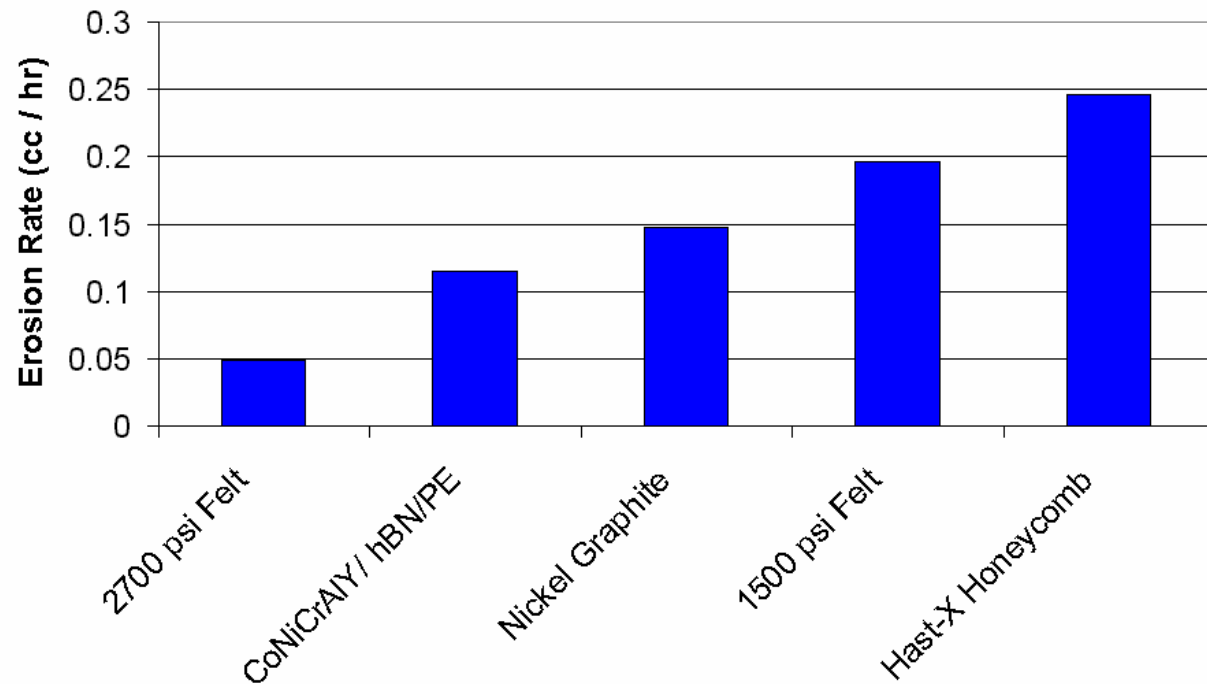
Temp:	70F
Rim Speed:	800 ft/s
Incur. Rates:	up to 0.4 mil/s
Axial Travel:	~ 400 mils
Radial Travel:	~ 160 mils
KE Width:	~ 80 mils



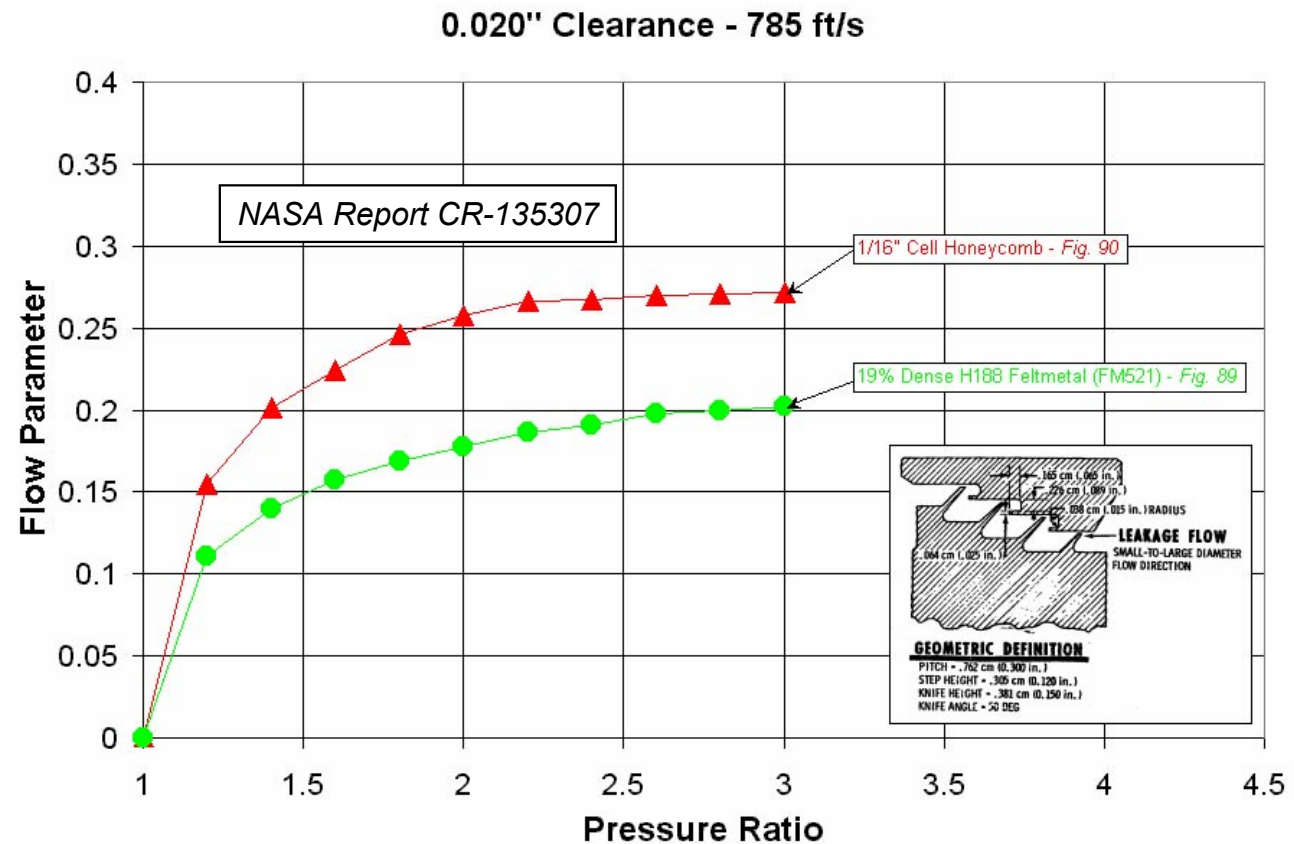
Erosion Test Results

Temp: 70F
Erodent:: 60u, Al2O3
Gas Vel: 425 ft/min
Angle: 20 deg
Feed Rate: 10 g/min
Duration: 30 min

Erosion Not As Significant A Concern At Many KE Seal Locations



Potential Benefit: Leakage Flow Reduction



Conclusions

- Like Prior Blade Tip Seal Testing, Knife Edge Seal Abradability Driven By Feltmetal® Tensile Strength.
- Feltmetal® Can Be Tailored To Meet Specific Application Requirement
- Initial Testing Indicates Simultaneous Plunge And Sweep Cutting Is No Problem

Future Work

- Titanium Knife Edge Data
- Mapping Limits At Low Interaction Rates
- Benchmark Against Competing Materials
(Honeycomb, Thermal Spray)
- Leakage Flow Testing
- Establish Industry Standards For
Erosion And Abradability Testing

